Jet Propulsion Laboratory
California Institute of Technology

Analysis of JPL Mission Cost Estimate Drivers

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Presentation in Brief

- Statistically significant common drivers occurred in late 1999-early 2000
- Project-specific drivers were identified through documents and interviews
- Better understanding of cost estimate drivers that could result in higher fidelity cost estimates

Outline

- Project description
- Information gathering process
- Contextualized cost estimate histories
- Identification of common drivers
- Statistical analysis
- Conclusions
- Future work
- Concluding remarks

Project Description and Context

- Objectives
  - Gather and consolidate data from key project personnel
  - Better understand factors that drive cost growth events
  - Follow the project lifecycle from formulation through implementation
- Purpose
  - Derive empirical principles that can increase the fidelity of early cost estimates
- JPL Context
  - New JPL Cost History Database consolidates actual charged costs
  - Current project complements Database with history of formulation estimates and EACs
  - Gain insight on primary common drivers that affect cost estimates
  - Previous studies examined Phases B/C/D

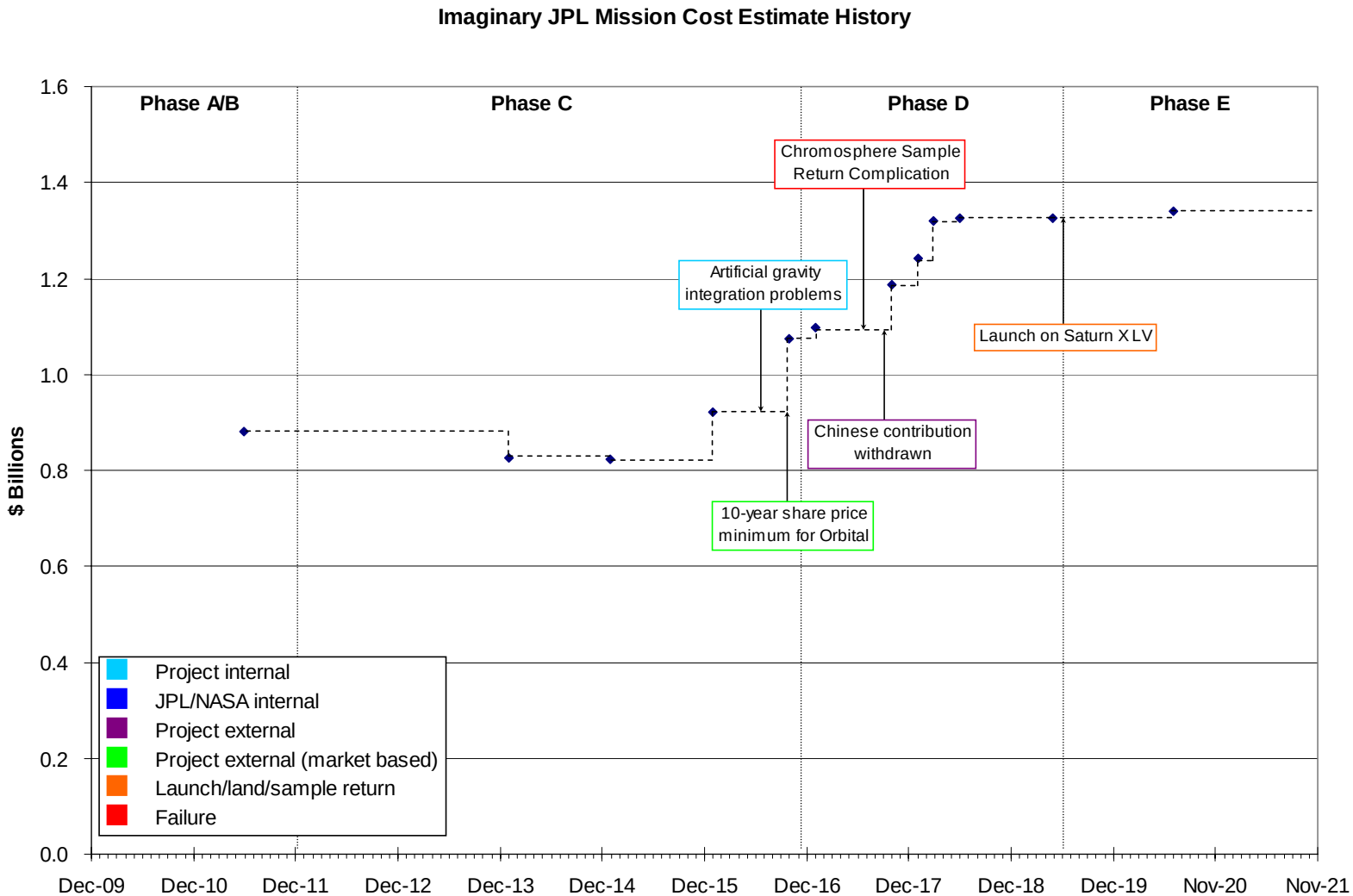
Information Gathering Process

- Interviews
  - PMs, PRAs, and other key individuals
- Documents and other sources
  - EDS
  - Project Financial Workforce Database
  - Technical Cost Database
  - DocuShare
  - Task orders
  - Project libraries
  - Personal files

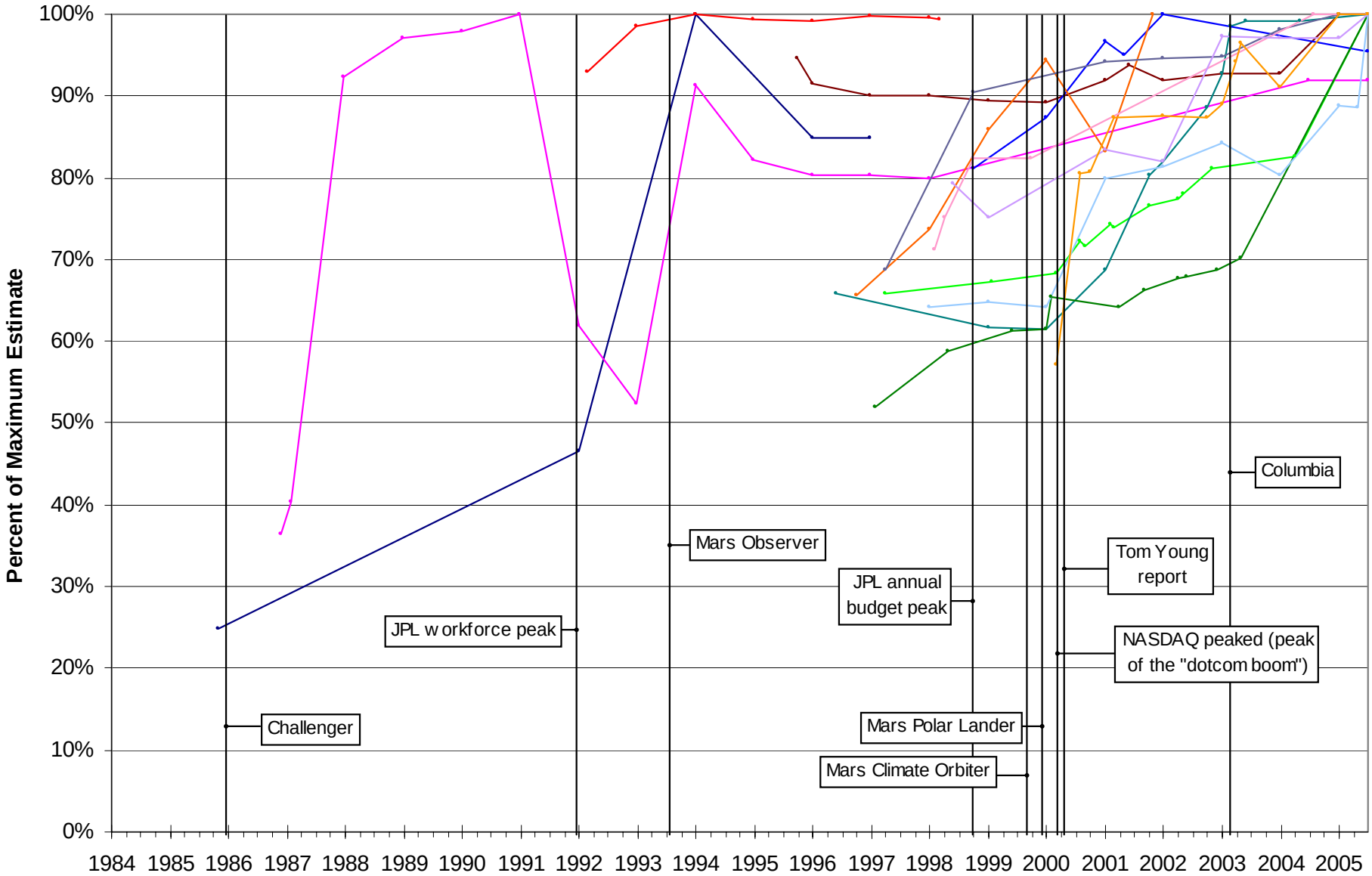
Cost Estimate Histories

- All values converted to FY05
  - Gives a better idea of true cost
  - Used NASA New Start Inflation Index (2005)
- Context generated primarily from interview notes
- Perceived driving factors differ between project personnel
- Cost estimates should not be considered single point events
  - Cost estimates are generated over a period of time
  - The indicated points correspond to dates of published information
- Data gaps may exist between estimates and events

Contextualized Cost Estimate Histories



Normalized Cost Estimate History



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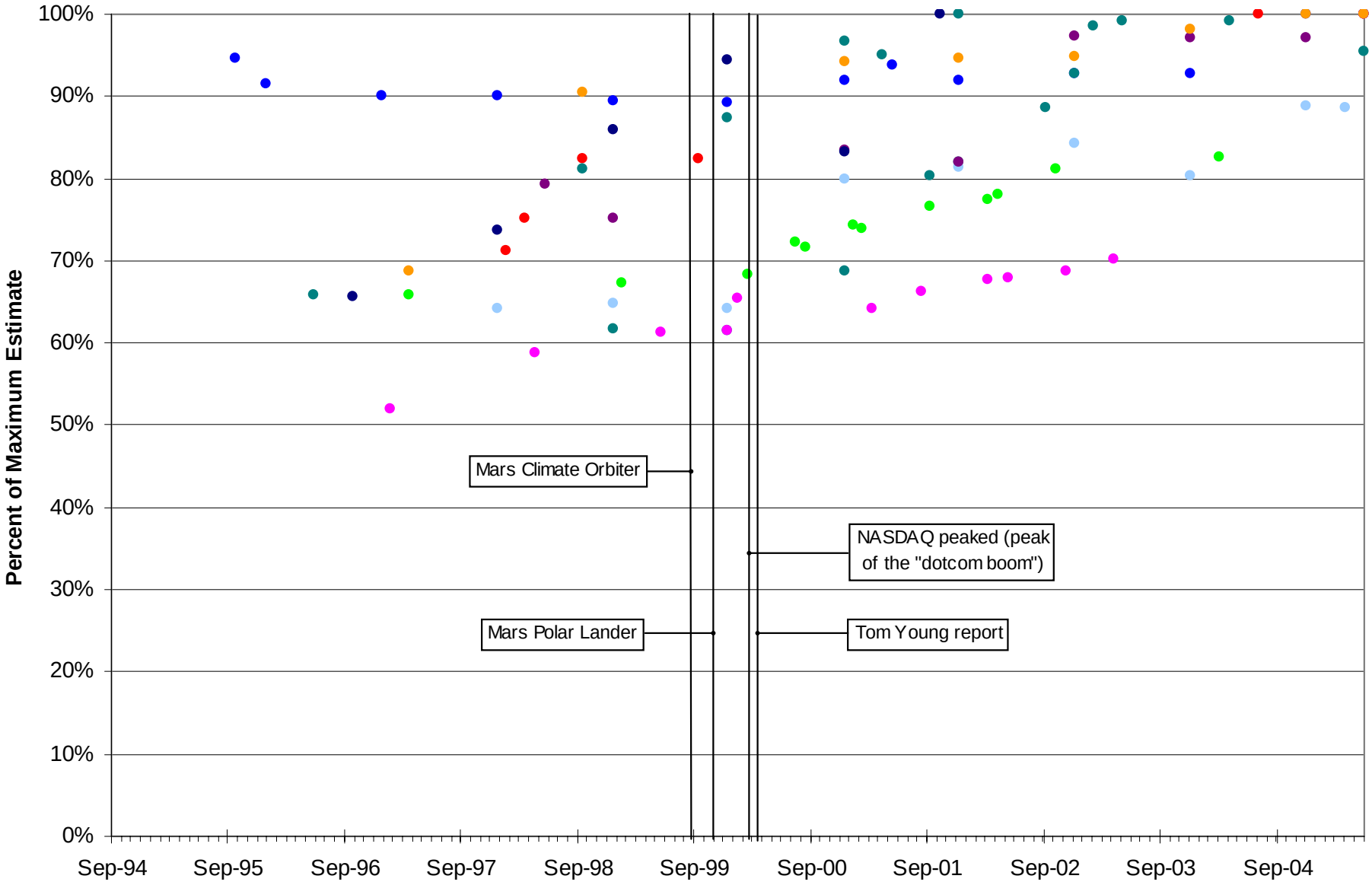

Statistical Analysis

- Two-factor Analysis of Variation (ANOVA) was performed on a time period from October 1998 to November 2001
  - Compares means by comparing measures of variability
  - Large enough project population to make viable statistical conclusions
  - Lack of data replication makes event isolation impossible
- Statistical effect of factor “project” much greater than factor “time”
  - Projects cover different missions and types with different governing paradigms…expected this behavior
  - Refocus on the effect of factor “time”
- Maximum variance occurs in January 2000

Primary Drivers

- JPL/NASA Mission Investigations
  - Seem to most affect missions that haven't launched yet
  - Cost increases due to increased reviews that compete with development time and often result in launch slips
  - Certain risks no longer considered acceptable
    - "They're all Class A on the launch pad." ~Dave Swenson
- Dotcom boom
  - "Brain drain" effect felt primarily by private industry
  - JPL contractors took longer to fulfill obligations and work quality slipped
- Administrative/governmental cost increases/funding delays
- Inadequate initial estimates and reserves
- Inadequate initial understanding of project complexity
  - Technical "scrambling"

Conclusions

- Some combination of events occurring near January 2000 had an effect on mission cost estimates for most of the investigated projects
- It is unlikely that a single event can be blamed for any particular cost estimate increase
- JPL is doing well considering the nature of its work

Future Work

- For future researchers
  - Comparative analysis with other centers to isolate drivers
  - Search for other significant factors
    - Project work force attrition
    - Look at directed versus competed missions and in-house versus system contracted
    - Follow paradigm shifts
- For JPL
  - Standard and enforced procedure for documenting cost estimation history
  - More accessible documentation

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- Mark Johnson
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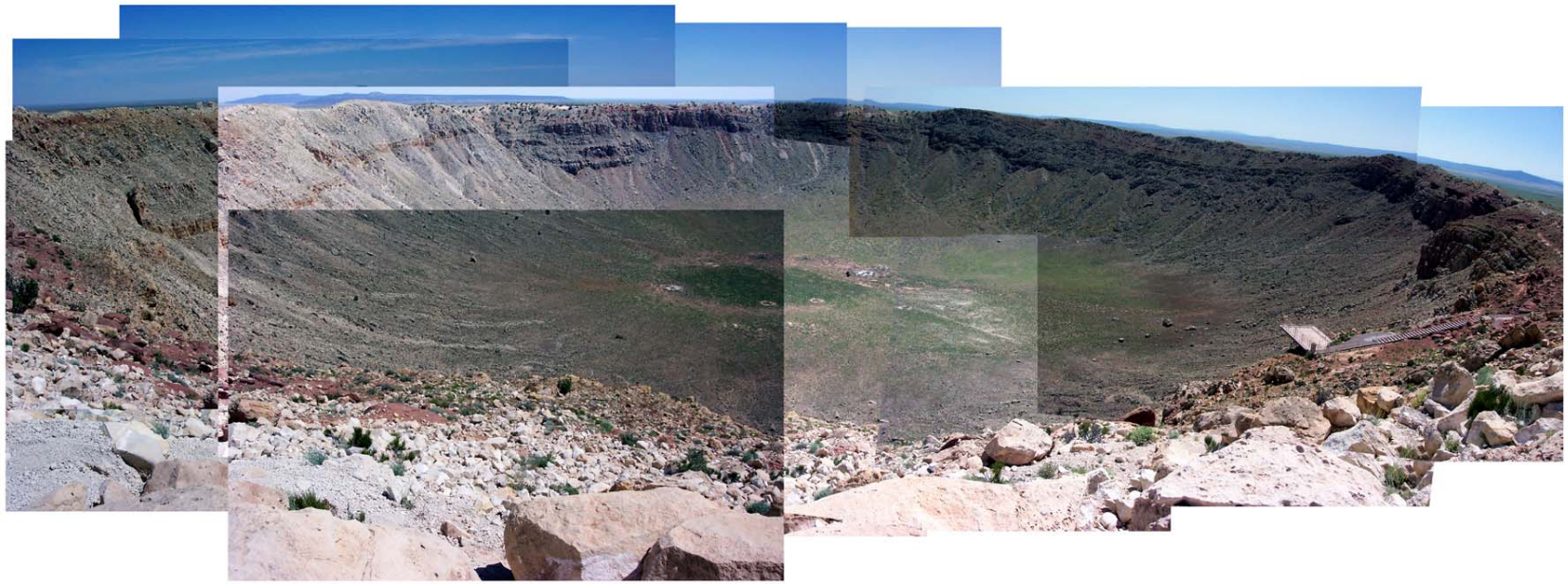
Questions?



Tommy Sebastian's Bio

- Senior @ NC State pursuing B.S. in Aerospace Engineering w/ a minor in Physics
  - Seeking concentration in space systems development
- Graduate from the SC Governor's School for Science and Mathematics
- AIAA President, NC State Student Chapter (2004-2005, 2005-2006)
- Electronics Development Team, Space Senior Design team leader (2005)
- USA TODAY All-USA College Academic Team (2005)
- NIAC Student Award Winner (Fall 2004)
- Publications
  - "Deployment Devices and Solar Power for Mars Tumbleweed Rovers," AIAA-2005-0246, 43rd AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV January 10-13, 2005.
  - "Feasibility of a Circular Three-Wing Planform Design as an Unmanned Aerial Vehicle (UAV)," 55th AIAA Southeastern Regional Student Conference, Memphis, TN, April 5-6, 2004.

Project Timeline

- Week 1 (June 6-10) Identify personnel to interview
- Week 2 (June 13-17) Consolidate existing documentation regarding mission histories
- Weeks 3, 4 (June 20-July 1) Complete identification of key knowledge carriers and augment existing foundation data with interviews
- Weeks 5, 6 (July 4-15) Consolidate information into databook
- Week 7, 8 (July 18-29) Analyze total foundation data and identify empirical principles
- Weeks 9,10 (August 1-10) Author final JPL report, final report (public), and present findings